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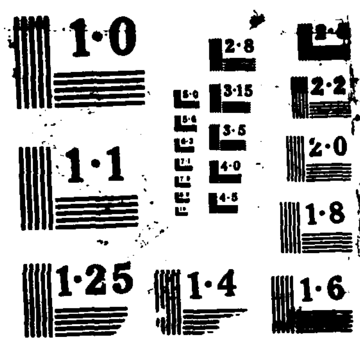
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FRANK J. SEILER RESEARCH LABORATORY

FJSRL-TR-87-0004 JUNE 1987

DYNAMIC FUNCTION ALLOCATION IN FIGHTER COCKPITS

FINAL REPORT

Capt Anthony Aretz, Lt Joseph Hickox, Lt Susan Kegler

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AIR FORCE SYSTEMS COMMAND

UNITED STATES AIR FORCE

87

FJSRL-TR-87-0004

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The objective of this study was to investigate alternatives for allocating the tasks associated with defensive counter measures in a fighter cockpit environment. The three methods allocated the functions either totally to the operator or a simulated expert system and dynamically at the operator's request to either. The analysis of the objective data showed there were no significant performance differences among the three treatment conditions. However, the analysis of post treatment subjective data showed the subjects did have confidence in the simulated expert systems's ability to handle the threats (p .01) and they had a significant preference for some form of computer assistance during the missions (p .01).

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ABSTRACT

The objective of this study was to investigate alternatives for allocating the tasks associated with defensive counter measures in a fighter cockpit environment. The three methods allocated the functions either totally to the operator or a simulated expert system and dynamically at the operator's request to either. The analysis of the objective data showed there were no significant performance differences among the three treatment conditions. However, the analysis of post treatment subjective data showed the subjects did have confidence in the simulated expert systems's ability to handle the threats ($p < .01$) and they had a significant preference for some form of computer assistance during the missions ($p < .01$).

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INTRODUCTION

Traditionally, a human factors engineer allocates functions in the design of a system based on a comparison between the operator's and the machine's ability to do the function using some form of the popular Fitts' list (Fitts, 1951). The function is usually allocated to the one that performs the task the best. This method has served well for most aviation systems until the recent advent of the automation revolution in cockpit design (Wiener and Curry, 1980). The Fitts' list method of allocating functions no longer works when the computer's abilities, at least in some aspects, are encroaching on those that have traditionally been reserved for the human operator. We now have computerized expert systems that can perform traditional human activities, such as heuristic reasoning, in such diverse areas as medical diagnosis, chemical spectral analysis, and geographical oil content surveys (Cohen and Figenbaum, 1982). The US Air Force has research underway to develop an expert system for a single seat fighter cockpit (Pohlmann and Payne, 1986; Shelnutt, Stenerson, Nelson, and Marks, 1986). What criteria can be used to allocate functions when human and computer abilities overlap?

Morris, Rouse, and Frey (1984) have advocated a concept of function allocation that is adaptive. That is, either the human operator or the computer accomplishes the function depending on whether the operator or the computer has been allocated the responsibility for the function. Adaptive allocation is executed dynamically in real time by either the operator or the computer, depending on who is in charge of the allocation decision. Thus, we now have a continuum for function allocation; from a fully manual system (the operator does everything), to a shared system (dynamic function allocation), to a fully automated system (the computer does everything and the operator monitors) (Wickens and Kramer, 1985).

Depending on a system's design constraints, any point on this continuum is feasible. In a single seat fighter cockpit environment, however, the shared function allocation scheme appears to be the best alternative. At the fully manual extreme the current situation would still exist where the pilot accomplishes most tasks, resulting in sometimes unacceptable levels of workload (Butterbaugh and Warner, 1981). Consequently, to reduce pilot workload there is a requirement for some form of cockpit automation (Air Force Studies Board, 1982). However, at the highly automated extreme there are also problems of system inflexibility and pilot skill erosion (Wiener, 1985). These problems are already evident in commercial aviation (Weiner and Curry, 1980). Thus, at least in the fighter cockpit environment, we are forced to use some function allocation strategy between these two extremes. Dynamic function allocation appears to be a possible solution.

The purpose of this research was to see if dynamic function allocation is a feasible alternative for fighter cockpit design. This was accomplished by imitating such a strategy in a simulated single seat fighter. Specifically, our hypothesis was that the presence of a simulated expert system that could be allocated tasks would significantly improve mission performance. There were three treatment conditions used to investigate this hypothesis: 1) automatic control of the defensive counter measures (DCM) by the computer, 2) dynamic control of the DCM by the computer at the option of the subject, and 3) a control condition where no computer aiding was available.

Another important variable to consider in the application of a dynamic function allocation scheme is operator confidence in the ability of the computer to perform its assigned tasks. If there is little or no trust, the operator will be forced to monitor the computer's performance. This would divert important attentional resources that could be used in the performance of the operator's own assigned tasks (Morris et al., 1984). Although operator trust in the computer was not manipulated in this experiment, it was subjectively assessed and it was hoped a high level of confidence could be achieved.

METHOD

Subjects

Eighteen male US Air Force Academy cadets ranging in age from 18-23 served as voluntary subjects. Subjects were initially screened based on their ability to play the video game simulation used in this study. This was done in an attempt to conceptually match the subject's skills to those of highly trained Air Force pilots.

Apparatus

Simulation. A single seat fighter cockpit environment was simulated using the F-15 Strike Eagle video game developed by Micro Prose. The game was played on a Kaypro 16 computer with a color monitor. F-15 Strike Eagle simulates seven air-to-ground mission scenarios with increasing levels of difficulty. In addition, these missions can be played at any one of four levels of challenge: arcade, rookie, pilot, and ace. The game also has a variety of threats (i.e., enemy aircraft and heat-seeking and radar-guided missiles) to deal with while flying the missions.

F-15 Strike Eagle uses four primary visual displays: a Head Up Display (HUD), tactical situation display, radar electronic warfare display, and a pictorial stores display (Figure 1). The offensive and defensive weapons include Electronic Counter Measures (ECM), flares, dumb bombs, and short and medium range missiles. For this experiment the ECM and flares were the only capabilities that could be allocated to the simulated expert system. The game also provides systems information on fuel, heading, airspeed, and altitude. From a human information processing perspective, this game realistically approximates the fighter cockpit environment quite well.

To further enhance the game's realism, it was played in a fixed-base T-38 cockpit simulator containing three color CRTs. The video game was presented on the CRT located in the HUD position. The subjects controlled the game through a joystick and computer keyboard that had been mounted in the cockpit. In

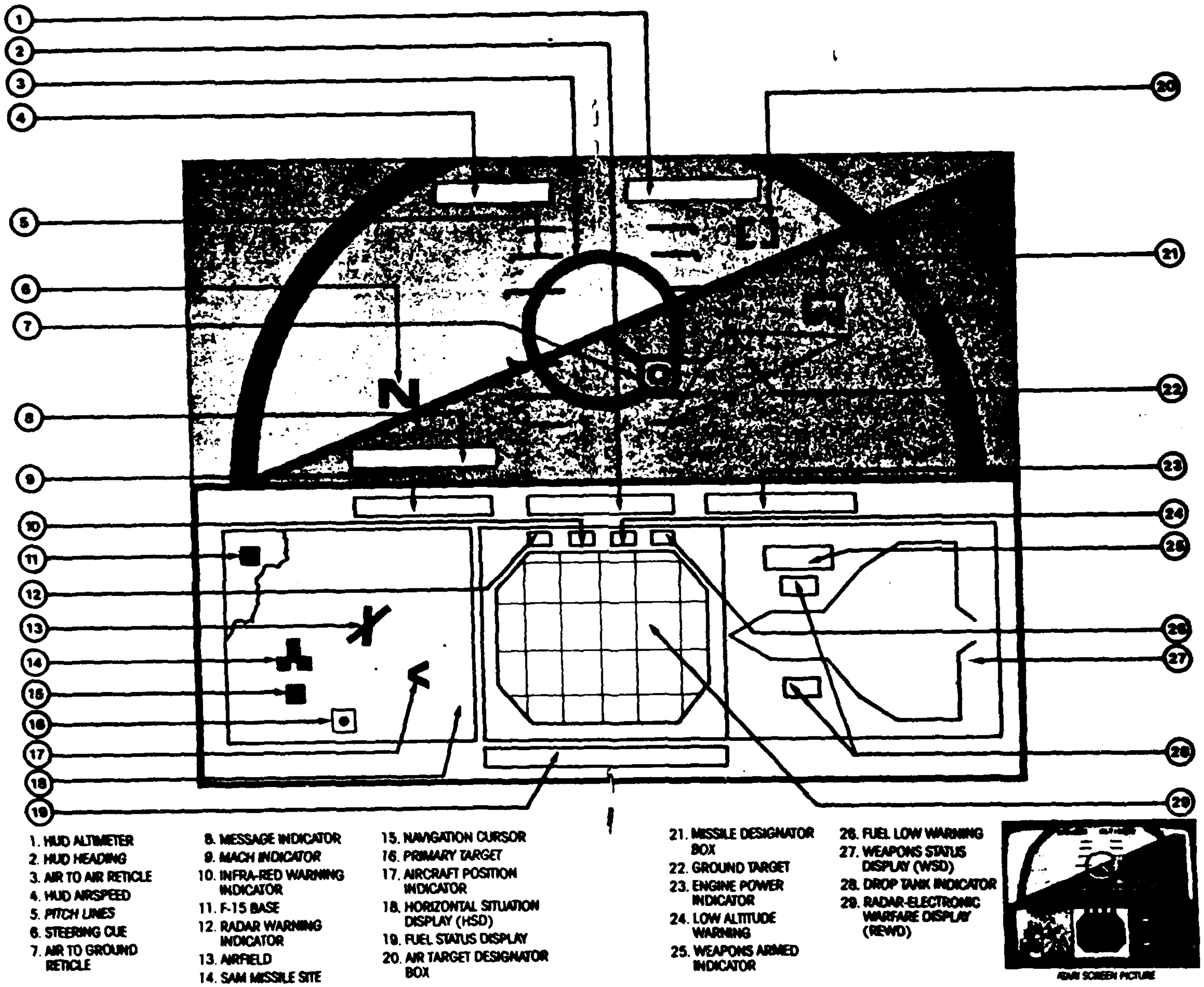

Figure 1. F-15 Strike Eagle Cockpit Layout.

addition, the subjects used a lighted push button switch mounted on the forward position of the left side panel to request computer aiding.

Expert system. An experimenter performed the functions of the expert system. A second computer keyboard located outside the cockpit, also connected to the Kaypro computer, could be used to control the game in an identical fashion as the keyboard mounted in the cockpit. The experimenter controlled which keyboard operated the game by a two position toggle switch. To further enhance the deception that the subject was using an actual expert system, a Texas Instruments Business Pro computer equipped with a TI Speech board and text-to-speech capability was used to advise the subject when the simulated expert system had deployed a flare or ECM. Specifically, the phrase used for flare deployment was: "Warning! Heat seeking missile, flare deployed"; the phrase used for ECM activation was: "Warning! Radar guided missile, ECM activated." The experimenter could track the mission on a separate CRT and select the correct DCM when appropriate.

Two experimenters simulated the expert system and each worked with half of the subjects. The experimenters were highly trained in playing the game and consistently used an optimal strategy (based on the program's user's manual and experience) for deploying DCM. Communications among the TI computer, subject, and experimenter occurred over an intercom system through microphones and headsets.

Experimental Design

The experimental paradigm used for this study was a one factor, within-subjects design. The three levels of the independent variable were: 1) automatic computer aiding, 2) dynamic computer aiding, and 3) a control condition where no computer aiding was given. The treatment order was counterbalanced using a balanced latin square design. The dependent variable was the total score for successfully completed missions during a single experimental session. For a mission to be considered successful, the subject was required to destroy the primary target and safely return to home base.

Procedures

Pre-test. Prior to participating in the experiment all subjects were tested in the simulator on their ability to play the video game. Each subject was required to successfully complete missions one, two, and three at the rookie level of difficulty before they were asked to participate. The pre-test was administered approximately one month prior to the experiment. The subjects were told not to play the video game again prior to their participation in the data collection portion of the study and all reported they had complied.

Experimental sessions. Subjects flew the simulation under each condition during three forty-five minute sessions. A forty-five minute session was chosen because: 1) if a subject flew all possible missions perfectly it would take approximately forty-five minutes and 2) usually a subject was available for only fifty minutes. Each subject flew each condition at approximately the same hour of the day on different days with at least one rest day between sessions.

Subject briefing. Prior to the session, the subjects were told which treatment they would see that day. The expert system was then described in a manner that lead the subjects to believe they were going to be aided by an actual computer. To further enhance the deception, the experimenter would then use the TI computer's text-to-speech synthesis to play the experimental instructions to the subjects (See Appendix A). The subjects were then reminded of the treatment condition and that their specific objective was to fly a successful mission as quickly as possible. They were told to only attack threats that endangered the success of the mission. For a dynamic allocation condition, the subjects were also briefed on the operation of the switch in the cockpit used to request aiding from the simulated expert system.

Data collection. A subject started each session flying mission number one at the rookie level of difficulty. If the mission was flown successfully, the subject then flew mission number two at the pilot level. However, if the mission was not successful (i.e., crashed, shot down, or failed to destroy the primary target), the subject repeated the same mission until it was completed successfully. If the subject completed these two missions successfully they then flew mission four also at the pilot level (mission number three was not used because it lacked air-to-air threats). If the subject was again successful they would be advanced to the ace level and would again fly missions number two and four. However, if the forty-five minute time period for the session had elapsed, the session was ended at that time. Only four subjects were able to complete the five possible missions during a session.

Upon completion of each successful mission the total score for that mission was displayed to the subject on the HUD and was recorded by the experimenter. Only total score was recorded because it was found in previous research that total score was the only variable sensitive to changes in performance (Arets, Guardino, McClain, and Porterfield, 1986). Following each session the subjects were administered a questionnaire using a five response Likert scale. A final questionnaire was given following all three treatments. The subjects were not told of the simulated nature of the expert system until all data had been collected. They were then fully debriefed as to the necessary nature of the deception involved.

RESULTS

The performance data were analyzed using the MANOVA for repeated measures procedure in the SPSS/PC+ statistical package for microcomputers (Norusis, 1986). (Even though there was only one dependent variable measured in this study the MANOVA procedure had to be used because this is the only procedure within SPSS/PC+ that allows a repeated measures model.) The results of this analysis revealed there were no significant performance differences among the three treatment conditions, $F(2,32)=.13$, $p>.1$. The means and standard deviations are shown in Table 1.

Table 1
Descriptive Statistics for Allocation Methods

Condition	M	SD
Automatic	9164	2797
Dynamic	9197	3327
Control	8875	3063

The subjective data obtained from the Likert scale questionnaires were analyzed using a Chi-Square goodness of fit test for a uniform distribution (See Appendix B). Some of the more interesting findings are as follows. First, 11 of the 18 subjects were confident in the computer's ability to handle the threats, $X^2(4,N=17)=13.9$, $p<=.01$. Second, all subjects preferred some form of computer assistance with 10 of the subjects selecting the dynamic mode as the best $X^2(2,N=17)=9.3$, $p<.01$. Third, 11 of the subjects rated the computer's ability to handle the threats as either good or very good $X^2(4,N=17)=9.8$, $p<.05$. Fourth, 14 of the subjects felt the computer's help actually improved their performance on the missions $X^2(4,N=17)=25.8$, $p<.001$. Finally, in the dynamic mode, 11 of the subjects felt they requested the computer's help either often or very often $X^2(4,N=17)=14.6$, $p<.001$. In addition, it was found that in the dynamic condition, subjects requested the help of the computer for an average period of 16 minutes, or approximately one third of the time.

DISCUSSION

Since the subjects in this experiment were selected based on their ability to play F-15 Strike Eagle, it is probably not surprising to find no significant performance differences among the three treatment conditions. Only in situations where the operator is already overloaded and unable to perform optimally would a difference be expected. In this study, the subjects could already play the video game quite well without any help. Therefore, the addition of the simulated expert system did not help to improve performance. Maybe the limited nature of the computer aiding in this study did not go far enough to actually aid performance. However, since most of the subjects did prefer some form of assistance from the expert system it can be surmised that although performance was not affected, the subjects at least thought it was helping. This is borne out by the questionnaire results.

Some of the subjects did comment that the computer helped to reduce their perceived workload. Although workload was not specifically addressed in this research, it appears the subjects were willing to rely on the expert system to make their task easier. As one subject commented: "It is definitely reduced workload having the computer handle flares & ECM."

Humans are quite flexible and can adapt to situations of varying workload and still perform admirably without any performance decrements; so even if there are no performance benefits to be gained from the addition of an expert system, operator workload may be reduced. Although this study provides no empirical evidence, it hints that by using an expert system to aid the operator, attentional resources may be used more efficiently. Future research should concentrate on objective workload differences in addition to performance differences.

Nevertheless, in order for an operator to rely on an expert system, they must be able to trust the computer to do its job well. What is considered good performance for one person may not be deemed good by another. At least in this study, most of the subjects felt the simulated expert system performed favorably. But not all subjects felt this way. Even though the expert system performed quite consistently and was simulated using only two experimenters who were highly trained experts in playing the game, some of the subjects still did not like the way the "computer" handled the DCM. This was probably because the simulated expert system (i.e., the experimenter) was deploying DCM using a different strategy than the subject would have (Morris et al., 1984). That is, the "computer's model" of how the DCM should be handled was different from that of the subject's. Three of the subjects commented that the computer did not react quickly enough, even though the experimenters were using an optimal strategy. One subject who rated the computer's aid as not helpful at all stated "The computer was way behind on flares and ECM". But this same subject still said that "it [the computer] was good to use on the target approach" [a high workload situation]. Another subject also stated the computer could have conserved flares better (there was a limited number) and another subject had commented that the computer waited too long to deploy DCM. But still only one subject rated the computer's performance as poor. It would be interesting to see how manipulation of factors such as these (i.e., the computer's decision making model) effect a subject's perceived performance of the computer.

Another point that probably needs to be made is that at the expert levels of F-15 Strike Eagle, it is very difficult to complete a mission successfully, even for a highly trained player. Only three subjects rated their overall performance as very good, with 11 subjects rating themselves as good or average. Therefore, a majority of the subjects perceived neither theirs nor the computer's performance as perfect at these expert levels. Morris et al. (1984) hypothesized that when an operator's perceived performance goes down, they are more likely to rely on a computer aid. This may have occurred in this experiment. Even though some of the subjects did not feel the computer performed well, they still relied on it during high workload situations, the point at which their perceived performance probably went down.

CONCLUSIONS

These results support the idea that in systems where highly trained operators are used to perform several concurrent complex tasks, the addition of an expert system to provide some form of computer aiding may not increase overall system performance;

unless the task is very difficult for an operator to perform well in the first place. This outcome may be the consequence of the limited nature of computer aiding used in this study; still, subjects preferred some form of computer help. The main benefit to be gained from an expert system appears to be the reduction of operator workload. Nonetheless, to gain any advantage from computer aiding, this study points to an important variable that needs to be considered -- operator trust in the computer. Specifically, how the operator's own internal performance model matches that of the computer's.

REFERENCES

Air Force Studies Board Committee. (1982). Automation in Combat Aircraft. Washington, D.C: National Academic Press.

Aretz, A., Guardino, A., McClain, J., and Porterfield, T. (1986). Expert System Advice: How Should it be Given? In Proceedings of the Human Factors Society 30th Annual Meeting (pp. 652-656). Santa Monica, CA: Human Factors Society.

Butterbaugh, L. and Warner, D. (1981). Pilot Workload a Survey of Operational Problems. (Tech. Report AFWAL-TR-81-3011). Wright-Patterson AFB, OH: Air Force Wright Aeronautical Laboratories.

Cohen, P.R. and Figenbaum, E.A. (1982). The Handbook of Artificial Intelligence, Volume II. Los Altos, CA: William Kaufmann Inc.

Fitts, P.M. (Ed.). (1951). Human Engineering for an Effective Air-Navigation and Traffic Control System. Washington, D.C.: National Research Council on Aviation Psychology.

Morris, N.M., Rouse, W.B., and Frey, P.R. (1984). A[illegible]ive Aiding for Human-Computer Control: Conceptual [illegible] and Experimental Approach. (Tech. Report AFAMRL-TR-84-[illegible] Wright-Patterson AFB, OH: Air Force Aerospace Medical Research Laboratory.

Norusis, M.J. (1986). SPSS/PC+ Advanced Statistics. Chicago, IL: SPSS Inc.

Pohlmann, L.D. and Payne, J.R. (1986). Pilot's Associate Demonstration One: A Look Back and Ahead. In Proceedings of the National Aerospace and Electronics Conference (pp. 1176-1183). Dayton, OH: IEEE.

Shelnutt, J.B., Stenerson, R.C., Nelson, P.C., and Marks, P.S. (1986). Pilot's Associate Demonstration One: A Look Inside. In Proceedings of the National Aerospace and Electronics Conference (pp. 1184-1189). Dayton, OH: IEEE.

Wickens, C.D. and Kramer, A. (1985). Engineering Psychology. Annual Review of Psychology, 16, 307-348.

Wiener, E.L. and Curry, R.E. (1980). Flight Deck Automation: Promises and Problems. Ergonomics, 23, 995-1012.

Wiener, E.L. (1985). Beyond the Sterile Cockpit. Human Factors, 27(1), 75-90.

APPENDIX A

Instructions to Subjects for the Request Condition

Hello. I am your on board intelligent computer. My purpose is to help you fly your mission successfully. During your missions, I can automatically activate your threat management capabilities when they are required in your request my help. To request my help you must press the "C" switch on the left front panel of the cockpit. Our attack orders are to fly directly to the target, attack the target, and return directly to home base. Only attack the threats that endanger the success of the mission. If you happen to get low on fuel, you may have to return to base to refuel before completing your mission. If you have any questions ask the experimenter at this time.

APPENDIX B

Questionnaire Results

FINAL QUESTIONNAIRE

SUBJECT:______________________

Circle the appropriate response:

1. Overall, did you find the keyboard very difficult to operate?

0	1	6	8	1
Very Difficult	Difficult	OK	Easy	Very Easy

$^{*}p < .05$

2. When the computer was handling the threats, were you confident in its ability to do a good job?

2	9	4	2	0
Definitely	Yes	So-So	No	Not at All

$^{*}p < .05$

3. Which mode of computer assistance did you prefer for the computer aided threat management?

0	7	10
None	Automatic	Requested

$^{*}p < .01$

4. Taking all three missions that you flew together, how would you rate just <u>YOUR</u> performance at the video game?

0	0	6	8	3
Very Poor	Poor	Average	Good	Very Good

$^{*}p < .01$

5. Taking the two missions together where the computer handled the threats, how would you rate just the <u>COMPUTER'S</u> performance?

0	1	5	7	4
Very Poor	Poor	Average	Good	Very Good

$^{*}p < .05$

6. Are there any other general comments you would like to make:

DYNAMIC CONDITION QUESTIONNAIRE

SUBJECT: ____________________

Circle the appropriate response below:

1. How would you assess just <u>YOUR</u> performance on today's missions?

0	3	5	6	2
Very Poor	Poor	Average	Good	Very Good

2. Did you find the keyboard very difficult to operate?

0	1	5	8	2
Very Difficult	Difficult	OK	Easy	Very Easy

$^*p < .01$

3. How often would you say you requested the computer's help?

2	9	3	2	0
Very Often	Often	Some	Not Often	Not at All

$^*p < .05$

4. When you did request the computer's help, did you find it helpful?

5	7	3	0	1
Very Helpful	Helpful	Somewhat Helpful	Not Helpful	Not Helpful At all

$^*p < .05$

5. Do you think the computer improved your performance on the missions?

5	6	4	1	0
Definitely	Yes	So-So	No	Not at All

$^*p < .1$

6. Were you confident in the computer's ability to handle the threats?

2	6	5	2	1
Definitely	Yes	So-So	No	Not at All

7. Are there any other comments you would like to make:

CONTROL CONDITION QUESTIONNAIRE

SUBJECT: ______________________

Circle the appropriate response below:

1. How would you assess your performance on today's missions?

0	4	5	5	2
Very Poor	Poor	Average	Good	Very Good

2. Did you find the keyboard very difficult to operate?

0	1	6	8	1
Very Difficult	Difficult	Somewhat	Easy	Very Easy

$^{*}p < .05$

3. Are there any other comments you would like to make:

AUTOMATIC CONDITION QUESTIONNAIRE

SUBJECT: ____________________________

Circle the appropriate response below:

1. How would you assess just <u>YOUR</u> performance on today's missions?

0	1	8	7	0
Very Poor	Poor	Average	Good	Very Good

$^{*}p < .001$

2. Did you find the keyboard very difficult to operate?

0	2	4	6	4
Very Difficult	Difficult	Somewhat	Easy	Very Easy

3. Do you think the computer's help improved your performance on the missions?

3	11	0	2	0
Definitely	Yes	Somewhat	No	Not at All

$^{*}p < .001$

4. Did you find the computer's voice in telling you what it was doing helpful?

4	7	3	2	0
Very Helpful	Helpful	So-So	Not Helpful	Not Helpful At All

$^{*}p < .1$

5. Were you confident in the computer's ability to handle the threats?

0	9	4	3	0
Definitely	Yes	So-So	No	Not at All

$^{*}p < .05$

6. Are there any other comments you would like to make:

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